

Psychological Science

<http://pss.sagepub.com/>

Genetic Relations Among Procrastination, Impulsivity, and Goal-Management Ability: Implications for the Evolutionary Origin of Procrastination

Daniel E. Gustavson, Akira Miyake, John K. Hewitt and Naomi P. Friedman

Psychological Science published online 4 April 2014

DOI: 10.1177/0956797614526260

The online version of this article can be found at:

<http://pss.sagepub.com/content/early/2014/04/04/0956797614526260>

Published by:



<http://www.sagepublications.com>

On behalf of:



[Association for Psychological Science](#)

Additional services and information for *Psychological Science* can be found at:

Email Alerts: <http://pss.sagepub.com/cgi/alerts>

Subscriptions: <http://pss.sagepub.com/subscriptions>

Reprints: <http://www.sagepub.com/journalsReprints.nav>

Permissions: <http://www.sagepub.com/journalsPermissions.nav>

>> [OnlineFirst Version of Record](#) - Apr 4, 2014

[What is This?](#)

Genetic Relations Among Procrastination, Impulsivity, and Goal-Management Ability: Implications for the Evolutionary Origin of Procrastination

Daniel E. Gustavson¹, Akira Miyake¹, John K. Hewitt^{1,2}, and Naomi P. Friedman^{1,2}

¹Department of Psychology and Neuroscience and ²Institute for Behavioral Genetics, University of Colorado Boulder

Psychological Science

1–11

© The Author(s) 2014

Reprints and permissions:

sagepub.com/journalsPermissions.nav

DOI: 10.1177/0956797614526260

pss.sagepub.com



Abstract

Previous research has revealed a moderate and positive correlation between procrastination and impulsivity. However, little is known about why these two constructs are related. In the present study, we used behavior-genetics methodology to test three predictions derived from an evolutionary account that postulates that procrastination arose as a by-product of impulsivity: (a) Procrastination is heritable, (b) the two traits share considerable genetic variation, and (c) goal-management ability is an important component of this shared variation. These predictions were confirmed. First, both procrastination and impulsivity were moderately heritable (46% and 49%, respectively). Second, although the two traits were separable at the phenotypic level ($r = .65$), they were not separable at the genetic level ($r_{\text{genetic}} = 1.0$). Finally, variation in goal-management ability accounted for much of this shared genetic variation. These results suggest that procrastination and impulsivity are linked primarily through genetic influences on the ability to use high-priority goals to effectively regulate actions.

Keywords

procrastination, impulsivity, goal management, self-control, heritability, individual differences

Received 8/2/13; Revision accepted 2/7/14

Procrastination—the voluntary but irrational delay of an intended course of action—is a widespread behavioral problem (Ferrari, 2010; Steel, 2010) that can be harmful not only to the procrastinator's psychological, physical, and financial well-being, but also to other people that count on him or her (Jaffe, 2013; Pychyl & Flett, 2012). Previous research, mostly based on self-report questionnaire measures, has established that one's tendency to procrastinate is a stable trait applicable to various everyday contexts (Steel, 2007; Steel & Ferrari, 2013). Previous research has also specified various personality traits associated with procrastination (for a meta-analytic review, see Steel, 2007).

Despite such progress in delineating the characteristics and correlates of individual differences in procrastination tendencies, relatively neglected questions concern the origins of procrastination. Some research has examined potential environmental factors influencing procrastination

tendencies, such as parenting style (Ferrari & Olivette, 1994) and social-support network (Ferrari, Harriott, & Zimmerman, 1999), but little systematic research has been conducted to address two fundamental questions. What makes some individuals more likely to procrastinate than others? What are the cognitive and biological (including genetic) factors underpinning such individual differences? We addressed these fundamental questions by conducting a multivariate behavior-genetics analysis of the relationship between procrastination and impulsivity. In doing so, we evaluated one recent evolutionary account of the origins of procrastination, namely that procrastination is a by-product of an evolutionarily more

Corresponding Author:

Daniel E. Gustavson, University of Colorado Boulder, Department of Psychology and Neuroscience, 345 UCB, Boulder, CO 80309
E-mail: daniel.gustavson@colorado.edu

basic trait, impulsivity (Steel, 2010). Moreover, we specified the cognitive basis of the procrastination-impulsivity link by demonstrating that individual differences in goal-management ability account for much of the shared variation between these traits.

At first glance, the idea that procrastination originated from impulsivity may be counterintuitive. Procrastination is about tendencies to intentionally delay actions, whereas impulsivity is about tendencies to make rash actions without thinking or planning (Lynam, Smith, Whiteside, & Cyders, 2006). If anything, they might seem like opposites (Ferrari, 1993). Substantial evidence, however, disconfirms the view that procrastination is inversely related to impulsivity. Ferrari (1993) found that these traits were positively correlated ($r_s = .23-.46$), which suggests that more impulsive individuals procrastinate more. Subsequent research replicated this result and established impulsivity as one of the strongest correlates of procrastination— $r = .41$, 95% confidence interval (CI) = [.37, .46], $k = 22$, $N = 4,005$ (Steel, 2007). What remains unclear is why these two traits are related. In this study, we tested the predictions derived from two complementary theoretical perspectives—one cognitive and one evolutionary—that can jointly provide novel explanations of this robust relationship between the two traits.

From the cognitive perspective, procrastination and impulsivity seem to share a common underlying cognitive ability, namely goal-management ability, defined here as the ability to actively maintain and, if necessary, retrieve (or reactivate) one's short-term and long-term goals to effectively guide behaviors. From this goal-management perspective, procrastination is about irrationally delaying actions that help accomplish one's important goals, whereas impulsivity is about giving in to temptations, often at the expense of making progress on important long-term goals. Thus, it seems plausible that much of the commonality between these traits reflects goal-management ability. Indeed, a recent theory, called *temporal-motivation theory* (Steel & König, 2006), proposes goal setting (Locke & Latham, 2002) as an important component of procrastination tendencies, but much of the existing research on individual differences in procrastination has focused on specifying personality variables related to procrastination and has largely neglected the cognitive mechanisms underlying procrastination. As a result, prior evidence demonstrating the link between goal-management ability and procrastination has been limited (Grope & Steel, 2008).

From the evolutionary perspective, a recent proposal by Steel (2010)—that procrastination is an evolutionary by-product of impulsivity—also highlights goal management as an important component of the procrastination-impulsivity relationship. According to this account, impulsivity was a useful trait for early

humans (hunter-gatherers) who needed to satisfy their basic survival needs quickly. In those preagricultural days, there may have been little reason to spend time creating long-term plans for the distant future; in fact, taking too much time thinking about the future could sometimes have been harmful if it meant distraction from satisfying immediate needs. The modern world, however, is structured differently. Modern-day humans must juggle and make progress on many long-term goals to ensure future successes. Although the environment has shifted to valuing long-term goals over immediate survival needs, the impulsive tendencies that have been firmly ingrained during the course of human evolution are still present. These tendencies make modern-day humans highly susceptible to succumbing to temptations and overlooking long-term goals, susceptibilities that result in procrastination.

Because procrastination is proposed to have its origins in an evolutionarily adaptive trait, impulsivity, Steel (2010) hypothesizes a genetic basis for procrastination: "Without a genetic component, the ability to procrastinate couldn't easily be passed on. We evolved to be procrastinators" (p. 52). Thus, according to this account, modern individuals with a greater genetic predisposition for impulsivity may also be more likely to procrastinate as a result of these same genetic influences.

Although intriguing, this evolutionary account is speculative in that no direct evidence exists to support such conjectures. In fact, to the best of our knowledge, no compelling report on the heritability of procrastination tendencies has been published.¹ Moreover, because the existing research has focused exclusively on phenotypic correlations, it is impossible to verify whether the positive procrastination-impulsivity relationship indeed reflects a common genetic basis.

To test these cognitively and evolutionarily based goal-management accounts of the procrastination-impulsivity relationship, we analyzed data from a large-scale twin study and decomposed individual differences in procrastination and impulsivity into common and unique sources of genetic and environmental influences. Specifically, we tested three predictions that can be derived from the complementary cognitive and evolutionary goal-management accounts. First, if procrastination is indeed wired in human genes through evolution, it should be a heritable trait, like impulsivity (Bezdjian, Baker, & Tuvblad, 2011; Niv, Tuvblad, Raine, Wang, & Baker, 2011). Second, if procrastination is an evolutionary by-product of impulsivity, the genetic influences on procrastination should overlap highly with those on impulsivity; there should be little or no genetic influences on procrastination aside from those shared with impulsivity. Finally, if these two traits are linked because of an underlying goal-management ability, individual variation

in everyday goal-management failures should account for much of this shared genetic variation between procrastination and impulsivity. We tested these predictions at the level of latent variables by using multiple measures of procrastination, impulsivity, and goal failures, thereby minimizing measurement error.

Method

Subjects

The analysis was based on 663 individuals (364 females, 299 males) from 347 same-sex twin pairs—181 monozygotic (MZ) and 166 dizygotic (DZ)—in the ongoing Colorado Longitudinal Twin Study. All individuals who had completed the study at the time of analysis were included here, although, in some cases, observations for individual questionnaires were missing (subjects did not receive a score for a questionnaire if they did not respond to at least 80% of the items in that questionnaire). The twins were representative of the general population in their cognitive abilities (for detailed characterizations of this sample, see Rhea, Gross, Haberstick, & Corley, 2013). The mean age when they completed the measures was 22.66 years ($SD = 1.12$).

Measures

The questionnaires, administered on computers, were all broad in scope and tapped domain-general aspects of procrastination, impulsivity, or goal failures, although some of them included domain-specific items. Representative items from these measures are shown in Table 1.

Procrastination. Levels of procrastination were assessed with (a) the General Procrastination Scale (GPS; Lay, 1986), (b) the average of three subscales (External Control, Goal Neglect, and Effort Avoidance) of the Volitional Components Inventory (VCI; Kuhl & Fuhrmann, 1998), and (c) the Prospective and Decision-Related Action Orientation vs. Hesitation subscale of the Action Control Scale (ACS; Kuhl, 1994). Because not all twins were attending college, none of the questionnaires included items related to academic procrastination. Of these scales, the GPS is used most often to measure procrastination, but these items and subscales of the VCI and ACS have also been used to assess procrastination before and have demonstrated high correlations with GPS scores (Blunt & Pychyl, 1998; Gropel & Steel, 2008).

Impulsivity. Impulsivity is a multifaceted trait, and different dimensions of impulsivity have been proposed (Lynam et al., 2006). We targeted two components of impulsivity on which previous research into the

procrastination-impulsivity relationship has focused (Ferrari, 1993; Steel, 2007): the tendencies to give into cravings (urgency) and to act without thinking or planning (lack of premeditation). Although other dimensions (e.g., sensation seeking) are sometimes conceived of as part of impulsivity, Steel's (2007) meta-analysis revealed that sensation seeking does not correlate with procrastination as strongly ($r = .17$, $k = 11$) as these other components of impulsivity ($r = .41$, $k = 22$). Thus, we used (a) the average of three subscales totaling 22 items (Negative Urgency, Positive Urgency, and Lack of Premeditation) from a 35-item shortened form of the UPPS-P Impulsive Behavior Scale (Lynam et al., 2006) and (b) the average of the 20 (out of 36) items from the Self-Control Scale (SCS; Tangney, Baumeister, & Boone, 2004) clearly related to urgency or lack of premeditation.²

Goal failures. Goal-management failures were assessed with two measures that concerned how well one can actively maintain and, if necessary, retrieve relevant task goals to guide one's actions: (a) the total score of the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), which measures "memory, attention, and psychomotor slips" as well as "everyday task failures" (Wallace, 2004, p. 307), and (b) the log-transformed average of items from three subscales (Short Term, Long Term, and Internally Cued) of the Prospective Memory Questionnaire (PMQ; Hannon, Adams, Harrington, Fries-Dias, & Gipson, 1995). The PMQ has one other subscale (the extent to which one adopts memory strategies to prevent the forgetting of future goals), but this scale was excluded because it does not assess actual goal-management failures and because previous research has suggested that it does not correlate significantly with impulsivity (Chang & Carlson, 2014).

Data analysis

The twin analysis is based on the following assumptions. MZ twins share 100% of their alleles identical-by-descent, whereas DZ twins share an average of 50% of their alleles identical-by-descent. Because both types of twins share a common environment (e.g., family) but differ in the degree to which they are related genetically, the extent to which MZ twins are more similar to each other than DZ twins are to each other provides information about the magnitude of genetic and environmental influences.

We analyzed the data with Mplus (Version 6.11; Muthén & Muthén, 2010), which adjusts for nonindependence (for phenotypic analyses) and missing data. Model fit was evaluated with chi-square tests (χ^2) and the root-mean-square error of approximation (RMSEA). A nonsignificant χ^2 result and an RMSEA less than .06 indicate

Table 1. Example Items From the Measures of Procrastination, Impulsivity, and Goal Failures

Trait, scale, and subscale	Example item
Procrastination	
General Procrastination Scale (Lay, 1986)	When planning a party, I make the necessary arrangements well in advance. (reverse-scored) If a bill for a small amount comes, I pay it right away. (reverse-scored) I am continually saying "I'll do it tomorrow."
Volitional Components Inventory (Kuhl & Fuhrmann, 1998)	
External Control	I don't get started until time is about to run out. I take care of unpleasant things only at the last minute.
Goal Neglect	I repeatedly postpone something. I tell myself: You can always do it tomorrow.
Effort Avoidance	I avoid difficult goals. I readily put difficult things aside.
Action Control Scale (Kuhl, 1994)	
Prospective and Decision-Related Action Orientation vs. Hesitation	When I know I must finish something soon: A. I have to push myself to get started. B. I find it easy to get it done and over with. When I have a boring assignment: A. I usually don't have any problem getting through it. B. I sometimes just can't get moving on it.
Impulsivity	
UPPS-P Impulsive Behavior Scale (Lynam, Smith, Whiteside, & Cyders, 2006)	
Positive Urgency	When I am really excited, I tend not to think of the consequences of my actions. When I am really ecstatic, I tend to get out of control.
Negative Urgency	I have trouble resisting my cravings (for food, cigarettes, etc.). When I feel rejected, I will often say things that I later regret.
(Lack of) Premeditation	My thinking is usually careful and purposeful. (reverse-scored) I am a cautious person. (reverse-scored)
Self-Control Scale (Tangney, Baumeister, & Boone, 2004)	I do many things on the spur of the moment. I am good at resisting temptation. (reverse-scored)
Goal failures	
Prospective Memory Questionnaire (Hannon, Adams, Harrington, Fries-Dias, & Gipson, 1995)	
Long Term	I forgot to return something I borrowed. I forgot to pass on a message to someone.
Short Term	I forgot to lock the door when leaving my apartment or house. I forgot to pay the bill when finishing a meal at a restaurant.
Internally Cued	I got part way through a chore and forgot to finish. I forgot what I came into a room to get.
Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982)	Do you find you forget what you came to shops to buy? Do you fail to notice signposts on the road?

good fit (Hu & Bentler, 1998). Significance of parameters was determined with χ^2 difference tests, adjusting for clustering when appropriate (in phenotypic models).

We focus on the additive genetic and nonshared-environmental (*AE*) model here because, as with many personality traits, there was no compelling evidence for shared-environmental influences in any of the analyses presented here—all estimates for shared-environmental

influences were small (< 9%; almost all were actually 0) and nonsignificant. Because many personality traits are known to have nonadditive genetic influences (Eaves, Heath, Neale, Hewitt, & Martin, 1998), we also tested for dominance at both univariate and multivariate levels of analysis. In a few cases, some evidence for dominance was found (e.g., the GPS and UPPS-P measures at the univariate level), but these effects were not consistent

Table 2. Descriptive Statistics and Twin 1–Twin 2 Correlations for Each Measure

Measure	<i>N</i>	<i>M</i>	<i>SD</i>	Range	Skewness	Kurtosis	<i>r</i> _{MZ}	<i>r</i> _{DZ}
General Procrastination Scale	663	2.60	0.57	1.10–4.60	0.06	–0.05	.56	.07
Volitional Components Inventory	662	2.84	0.95	1.00–5.79	0.37	–0.25	.39	.10
Action Control Scale	659	7.88	2.93	0.00–12.0	–0.48	–0.61	.32	.05
Self-Control Scale	661	3.42	0.61	1.40–4.85	–0.35	0.10	.47	.13
UPPS-P Impulsive Behavioral Scale	637 ^a	1.97	0.42	1.05–3.59	0.36	0.23	.48	–.03
Prospective Memory Questionnaire	649	0.63	0.30	0.00–1.70	0.49	0.06	.48	.14
Cognitive Failures Questionnaire	663	1.41	0.47	0.13–3.26	0.31	0.62	.47	.26

Note: See Table 1 for more information about the measures. MZ = monozygotic, DZ = dizygotic.

^aThe UPPS-P, which was administered as part of a separate study, was shortened for time reasons to 22 items by eliminating some redundant items. Seventeen subjects had not completed that study at the time of analysis, and an additional 6 subjects had completed a different initial version of that study. Thus, these 23 subjects were missing data for the UPPS-P.

across models. Moreover, in all models with multiple nonadditive genetic factor loadings, it was possible to drop these loadings without a significant decrement in fit, thus justifying the current focus on the *AE* models.³

Although sex was previously found to be weakly yet significantly correlated ($r = .08$) with procrastination in large samples (Gropel & Steel, 2008; Steel & Ferrari, 2013), there were no significant sex differences in our sample, either in means or parameter estimates in the univariate twin models. Thus, sex was not included in the models reported here.

Results

Descriptive statistics and twin correlations are summarized in Table 2. Zero-order phenotypic correlations are shown in Table 3.

We first replicated the phenotypic correlation between procrastination and impulsivity at a latent-variable level. As shown in Figure 1a, a two-factor model assuming that procrastination and impulsivity are correlated yet separable fit the data well, $\chi^2(4) = 6.80$, $p = .147$, RMSEA = .032, and each measure had a significant factor loading on its respective trait. The phenotypic correlation between

procrastination and impulsivity was .65 (95% CI = [.58, .71]). This correlation was higher than Steel's (2007) meta-analytic estimate of .41, likely because of the use of manifest variables in previous research, which may underestimate the magnitude of the procrastination-impulsivity relationship. The zero-order correlations between the individual procrastination and impulsivity measures, shown in Table 3, are closer to Steel's estimates. Of note, it was not possible to collapse procrastination and impulsivity into one latent construct without a significant decrement in fit, $\chi^2(1) = 229.69$, $p < .001$, which suggests that, phenotypically, these traits are correlated yet separable constructs.

The genetic model that decomposes the phenotypic correlation we found between the two traits into additive genetic (*A*) and nonshared-environmental (*E*) components is shown in Figure 1b. This model shows that not only impulsivity but also procrastination are moderately heritable traits ($b^2 = .49$ and .46, respectively). More important, the genetic correlation between procrastination and impulsivity was estimated at 1.0 (95% CI = [.86, 1.0]), $\chi^2(106) = 111.96$, $p = .327$, RMSEA = .018, which suggests that overlapping genetic influences accounted for all of the genetic influences on both traits (i.e., there

Table 3. Phenotypic Correlations and Reliabilities for Each Measure

Measure	GPS	VCI	ACS	SCS	UPPS-P	PMQ	CFQ
General Procrastination Scale (GPS)	.89						
Volitional Components Inventory (VCI)	.66	.92					
Action Control Scale (ACS)	.61	.59	.77				
Self-Control Scale (SCS)	.51	.48	.39	.88			
UPPS-P Impulsive Behavioral Scale (UPPS-P)	.44	.40	.30	.69	.88		
Prospective Memory Questionnaire (PMQ)	.54	.46	.44	.49	.44	.91	
Cognitive Failures Questionnaire (CFQ)	.52	.47	.48	.46	.41	.67	.90

Note: $N = 633$. All correlations were significant ($p < .05$). Reliabilities (Cronbach's α) are shown on the diagonal in boldface. See Table 1 for more information about the measures.

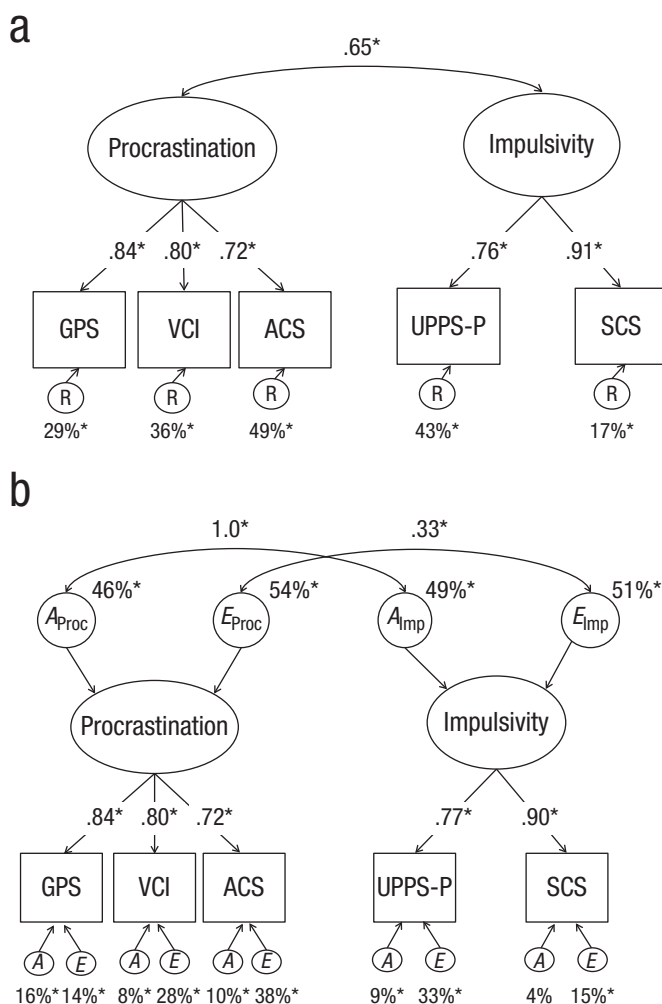


Fig. 1. Phenotypic model (a) and final bivariate genetic model (b) of procrastination (Proc) and impulsivity (Imp). Latent variables are indicated by circles and ovals, whereas manifest variables are indicated by squares. Values on double-headed arrows are correlations, and values on single-headed arrows are factor loadings. Values with percentage signs indicate the percentage of variance accounted for by genetic (A) or nonshared-environmental (E) influences, as well as by residual (R) factors. An asterisk indicates a significant factor loading or correlation ($p < .05$). GPS = General Procrastination Scale, VCI = Volitional Components Inventory, ACS = Action Control Scale, UPPS-P = UPPS-P Impulsive Behavior Scale, SCS = Self-Control Scale, R = residual. See Table 1 for more information about the measures.

were no unique genetic influences affecting only one trait). This high genetic correlation means that the phenotypic correlation of .65 is mostly (73%) due to shared genetic influences. These findings are consistent with Steel's (2010) proposal that, genetically, procrastination is an evolutionary by-product of impulsivity.

Figure 1b also shows that there was an additional significant nonshared-environmental correlation of .33 (95% CI = [.14, .50]), but this correlation was far from 1.0, $\chi^2(1) = 91.71$, $p < .001$. Thus, although impulsivity

and procrastination share some environmental influences, it is mainly unique environmental influences that make the two traits phenotypically separable.

Finally, we examined to what extent the shared genetic variation between procrastination and impulsivity is also shared with variation in goal-management ability. To do so, we added a latent variable for goal failures to both our phenotypic and genetic models. Phenotypic analyses revealed that goal failures were highly correlated with both procrastination and impulsivity ($r_s = .74$ and $.64$, respectively, $p < .001$). Moreover, the phenotypic correlation between procrastination and impulsivity (.65) was reduced to .39 after we controlled for shared variation with goal failures, which suggests that there is shared variation among all three traits.

The genetic model (Cholesky decomposition) is shown in Figure 2, $\chi^2(201) = 221.27$, $p = .151$, RMSEA = .025, in which common additive genetic (A_{Com}) and non-shared-environmental influences (E_{Com}) predict variation in all three traits. The model also includes the genetic and environmental factors that are shared only between procrastination and impulsivity ($A_{P\&I}$ and $E_{P\&I}$) and those specific to only procrastination (A_{Proc} and E_{Proc}). Of interest here is the magnitude of the genetic influences shared between procrastination and impulsivity ($A_{P\&I}$) after accounting for the genetic influences common to all three traits (A_{Com}).

As shown in Figure 2, the common genetic factor (A_{Com}) accounted for a substantial portion of the variation in both procrastination and impulsivity (34% for both traits) as well as goal failures (59%). More important, genetic influences specific to procrastination and impulsivity ($A_{P\&I}$) explained a much smaller portion of the variation in each trait (13% and 19%, respectively). There were no unique genetic influences on procrastination alone (0%). These results suggest that, as hypothesized, genetic influences on goal management substantially (if not entirely) overlap with those shared between procrastination and impulsivity.

Figure 2 also shows the effects of nonshared environments. Some of the total variation in procrastination can be explained by nonshared-environmental influences (E_{Com}) common to all three traits (23%) as well as by nonshared-environmental influences (E_{Proc}) specific to just procrastination (30%). However, there was no nonshared-environmental influence on procrastination ($E_{P\&I}$) common to only procrastination and impulsivity (0%).

To better quantify the extent to which the shared variation between procrastination and impulsivity is accounted for by variation in goal failures, we summarized our key results using an alternative format (Fig. 3), in which factor loadings from the phenotypic and Cholesky models were used to calculate the overall percentage of variation shared between procrastination and

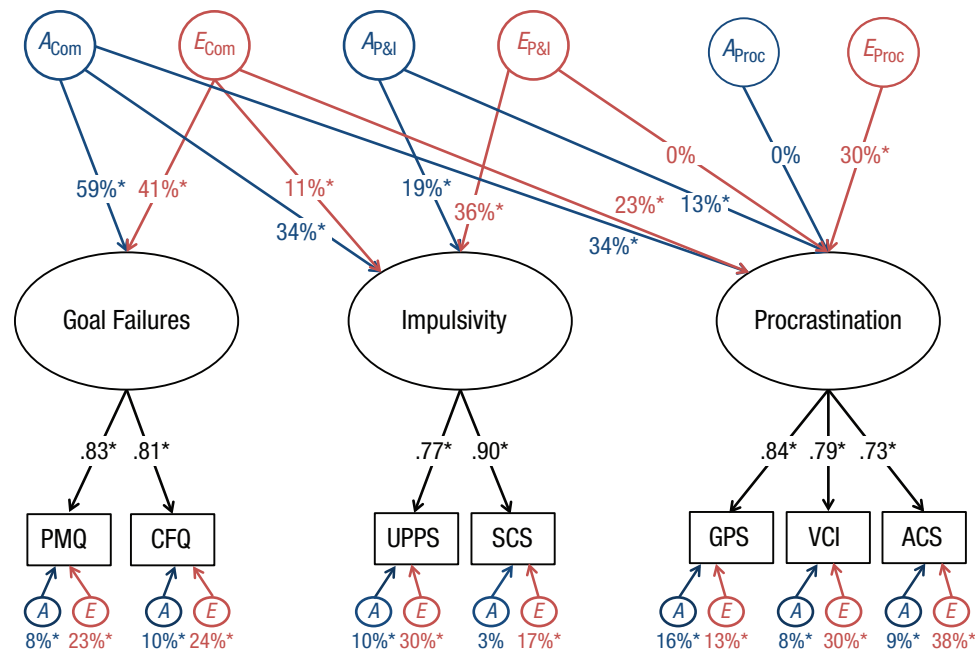


Fig. 2. Cholesky decomposition model of the genetic and environmental influences common to all three traits (Com), shared between procrastination and impulsivity but not with goal failures (P&I), and specific to only procrastination (Proc). Latent variables are indicated by circles and ovals, whereas manifest variables are indicated by squares. Values with percentage signs indicate the percentage of variance accounted for by genetic (*A*) or nonshared-environmental (*E*) influences. Values on paths between latent and manifest variables are factor loadings. An asterisk indicates a significant factor loading or percentage of variance ($p < .05$). PMQ = Prospective Memory Questionnaire, CFQ = Cognitive Failures Questionnaire, UPPS-P = UPPS-P Impulsive Behavior Scale, SCS = Self-Control Scale, GPS = General Procrastination Scale, VCI = Volitional Components Inventory, ACS = Action Control Scale. See Table 1 for more information about the measures.

impulsivity and the percentage of this shared variation that is also shared with goal failures. Phenotypically (Fig. 3a), 42% of the variation in procrastination was shared with impulsivity, and 74% of this shared variation was also shared with goal failures. Genetically (Fig. 3b), of the 100% of the genetic variation in procrastination shared with impulsivity, more than two-thirds (68%) of this shared genetic variation is also shared with goal failures. These results suggest that the shared genetic influences on procrastination and impulsivity are substantially shared with goal-management failures, although some genetic influences (32%) shared between procrastination and impulsivity cannot be explained solely by goal failures.

Discussion

In the current study, we tested and confirmed three predictions derived from the cognitive and evolutionary accounts of the procrastination-impulsivity relationship. First, procrastination showed substantial genetic contributions ($h^2 = .46$). Second, the genetic correlation between procrastination and impulsivity was estimated to be 1.0, which suggests that once genetic variation

shared with impulsivity is accounted for, there is no genetic variance left unique to procrastination. Finally, this shared genetic variation overlapped substantially (68%) with genetic variation in the tendency to fail to activate and maintain short-term and long-term goals, thus supporting the view that goal-management ability underlies the genetic commonality between procrastination and impulsivity.

Although these results support the proposal that procrastination is an evolutionary by-product of impulsivity (Steel, 2010), it is important to note that we cannot infer causation from these correlational data: Instead of procrastination being a by-product of impulsivity, impulsivity could be a by-product of procrastination. In fact, it has been suggested that procrastination and impulsivity show positive correlations because procrastination may lead to impulsive responding when deadlines are fast approaching (Ferrari, 1993, 2010). Although this alternative possibility cannot be entirely dismissed, it is difficult to see how it would explain the observation that the genetic correlation between procrastination and impulsivity was 1.0. In contrast, Steel's (2010) account provides a natural explanation for such a substantial genetic overlap between the two traits.

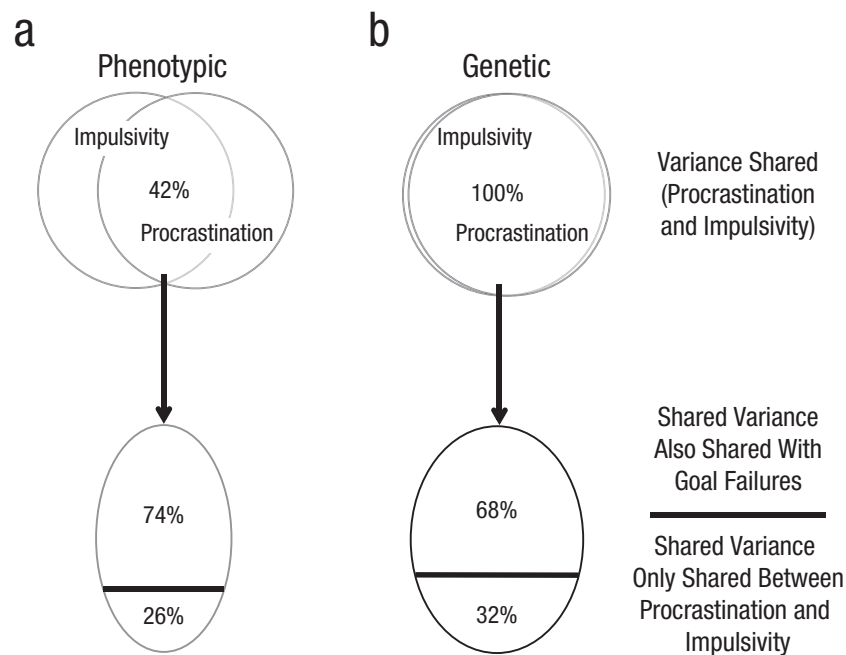


Fig. 3. Decomposition of the shared variation between impulsivity and procrastination into the amount also shared with goal failures at the phenotypic level (a) and the genetic level (b). The lower ovals describe how much of the shared variation from the upper diagram is also shared with goal failures.

In addition, although we interpret our results as consistent with the view that goal-management ability underlies the procrastination-impulsivity relationship, one could argue that the substantial commonality among the three traits primarily reflected method variance due to the use of questionnaires, rather than goal-management ability per se. Although we cannot deny some contribution of the method variance, this alternative explanation is unlikely because another trait assessed with questionnaires—perfectionism—did not explain much of the genetic commonality between procrastination and impulsivity. Perfectionism, often considered an important personality correlate of procrastination (Flett, Hewitt, & Martin, 1995; Pychyl & Flett, 2012), was correlated significantly with both procrastination and impulsivity in this sample ($r_s = .24$ and $.34$, $p < .001$, respectively).⁴ However, it accounted for little shared variation between procrastination and impulsivity (13% and 8% at the phenotypic and genetic levels, respectively), which suggests that the shared variation between procrastination and impulsivity is unlikely to be due to other correlated constructs (e.g., perfectionism) or potential biases due to self-reporting.

The results reported here are novel and important for several reasons. First, this study goes beyond prior studies of the procrastination-impulsivity relationship by testing the relationship at the level of latent (rather than manifest) variables. Second, to the best of our knowledge, this is the first twin study that reports the heritability of

procrastination tendencies. Third, this study provides new insights into the origin of the positive phenotypic relationship between procrastination and impulsivity. Moreover, by analyzing the procrastination-impulsivity relationship at the genetic level, the study provides a rigorous test of Steel's (2010) account of the etiology of procrastination and thereby demonstrates that behavior-genetics studies such as this one can provide a compelling way to test theoretical accounts, in addition to quantifying the genetic and environmental contributions to traits. Finally, this study provides the first evidence that shared variation between procrastination and impulsivity can be explained by one's goal-management ability. This new finding not only helps develop more mechanistic models of procrastination (Krause & Freund, 2013; Steel, 2010) but also points to promising new ways to reduce procrastination (e.g., increasing the likelihood of activating and maintaining appropriate goals in the presence of potential temptations).

An important direction for future research is to better specify the nature of the goal-management ability shared between procrastination and impulsivity. One possibility is that the goal-management ability examined in this study reflects individual differences in self-regulation ability or executive functions, a set of complex cognitive abilities that control and regulate behavior (Miyake et al., 2000; Miyake & Friedman, 2012). Procrastination is frequently considered a failure of self-regulation (Pychyl

& Flett, 2012; Rabin, Fogel, & Nutter-Upham, 2011; Senecal, Koestner, & Vallerand, 1995), and so is impulsivity. At a more mechanistic level, executive functions are considered crucial for goal-driven behaviors and have shown substantial heritability (Friedman et al., 2008). In light of the evidence that goal-management ability may be a central underlying problem for both procrastination and impulsivity, executive functions may also be predictive of individual differences in both of these traits, especially at the genetic level.

Although the current study advances the understanding of the origins of procrastination and the nature of its relationship to impulsivity, we also acknowledge two limitations. First, this study focused on domain-general aspects of procrastination and impulsivity. Although existing evidence suggests that both procrastination and impulsive tendencies manifest themselves across different domains (Steel, 2007; Tangney et al., 2004), there is also evidence that people may procrastinate or act impulsively only on certain tasks (e.g., Tsukayama, Duckworth, & Kim, 2012). Such domain-specific effects may show substantially different patterns of genetic and environmental influences. Second, although we interpret the high genetic correlation as indicative of overlapping genetic influences, there are other interpretations (e.g., gametic-phase disequilibrium due to assortative mating) that, in some cases, do not necessitate that the exact same alleles influence both traits (Carey, 1988; Keller et al., 2013). Although it is not clear how these alternative interpretations can explain the specific patterns of results reported here, it is nevertheless important to keep such general limitations of genetic analyses in mind.

In summary, we used behavior-genetics methodology to test specific predictions derived from goal-management accounts of the relationship between procrastination and impulsivity. We showed that genetic variations for procrastination and impulsivity overlap substantially and that these shared genetic influences explain the majority of the phenotypic correlation between these traits and highly overlap with genetic influences on goal-management ability. In other words, procrastinators are also impulsive in large part because they fail to manage goals effectively to guide their behaviors. Such results are consistent with the proposal that procrastination may be an evolutionary by-product of impulsivity (Steel, 2010). These findings also provide important new constraints on further theoretical development regarding the nature and origins of procrastination tendencies, and they suggest new approaches to developing effective intervention methods to reduce procrastination.

Author Contributions

D. E. Gustavson, A. Miyake, and N. P. Friedman conceived and designed the study. Data were collected by trained research

assistants at the Institute for Behavioral Genetics at the University of Colorado Boulder under the supervision of N. P. Friedman and J. K. Hewitt. All analyses were performed by D. E. Gustavson and N. P. Friedman in consultation with A. Miyake. D. E. Gustavson, A. Miyake, and N. P. Friedman drafted the manuscript, and all authors approved the final version of the manuscript for submission.

Acknowledgments

We thank Robin Corley and Sally Ann Rhea for their assistance with data collection and study coordination.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research was supported by Grants MH063207, HD010333, and DA011015 from the National Institutes of Health.

Notes

1. Steel (2007) cited a conference presentation reporting the heritability of procrastination tendencies ($b^2 = .22$), but this result is not included in the published report (Arvey, Rotundo, Johnson, Zhang, & McGue, 2006). Another study reported a heritability estimate ($b^2 = .18$) based on a single questionnaire item (Cesarini, Johannesson, Magnusson, & Wallace, 2012).
2. Two items directly related to procrastination were not included in this 20-item scale. We validated the coherence of this impulsivity subscale by conducting exploratory factor analysis on all items. Most of the 20 identified items loaded highly on the first factor. The other items mostly concerned health, organization, and time management, and hence were excluded from these analyses.
3. This lack of evidence for dominance is partly due to insufficient power to differentiate additive from nonadditive genetic effects in a traditional twin model (Martin, Eaves, Kearsy, & Davies, 1978). Thus, the genetic estimates provided here should be interpreted as broad-sense heritability (the overall effect of genes) rather than narrow-sense heritability (specific to additive genetic influences).
4. This additional analysis was conducted with two measures of perfectionism, the Concern for Mistakes and Parental Criticism subscales of the Modern Perfectionism Scale (Frost, Marten, Lahart, & Rosenblate, 1990), which have been shown to positively correlate with levels of procrastination.

References

- Arvey, R. D., Rotundo, M., Johnson, W., Zhang, Z., & McGue, M. (2006). The determinants of leadership role occupancy: Genetic and personality factors. *The Leadership Quarterly*, 17, 1–20. doi:10.1016/j.leaqua.2005.10.009
- Bezdjian, S., Baker, L. A., & Tuvblad, C. (2011). Genetic and environmental influences on impulsivity: A meta-analysis of twin, family, and adoption studies. *Clinical Psychology Review*, 31, 1209–1223. doi:10.1016/j.cpr.2011.07.005

- Blunt, A., & Pychyl, T. A. (1998). Volitional action and inaction in the lives of undergraduate students: State orientation, procrastination and proneness to boredom. *Personality and Individual Differences*, 24, 837–846. doi:10.1016/S0191-8869(98)00018-X
- Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, 21, 1–16.
- Carey, G. (1988). Inference about genetic correlations. *Behaviour Genetics*, 18, 329–338. doi:10.1007/BF01260933
- Cesarini, D., Johannesson, M., Magnusson, P. K. E., & Wallace, B. (2012). The behavioral genetics of behavioral anomalies. *Management Science*, 58, 21–34. doi:10.1287/mnsc.1110.1329
- Chang, J., & Carlson, S. R. (2014). Trait impulsivity and prospective memory abilities: An exploratory analysis. *Personality and Individual Differences*, 56, 40–44. doi:10.1016/j.paid.2013.08.016
- Eaves, L. J., Heath, A. C., Neale, M. C., Hewitt, J. K., & Martin, N. G. (1998). Sex differences and non-additivity in the effects of genes on personality. *Twin Research*, 1, 131–137.
- Ferrari, J. R. (1993). Procrastination and impulsiveness: Two sides of a coin? In W. G. McCown, J. L. Johnson, & M. B. Shure (Eds.), *The impulsive client: Theory, research, and treatment* (pp. 265–276). Washington, DC: American Psychological Association.
- Ferrari, J. R. (2010). *Still procrastinating: The no regrets guide to getting it done*. Hoboken, NY: John Wiley & Sons.
- Ferrari, J. R., Harriott, J. S., & Zimmerman, M. (1999). The social support networks of procrastinators: Friends or family in times of trouble? *Personality and Individual Differences*, 26, 321–331. doi:10.1016/S0191-8869(98)00141-X
- Ferrari, J. R., & Olivette, M. J. (1994). Parental authority influences on the development of female dysfunctional procrastination. *Journal of Research in Personality*, 28, 87–100. doi:10.1006/jrpe.1994.1008
- Flett, G. L., Hewitt, P. L., & Martin, T. R. (1995). Dimensions of perfectionism and procrastination. In J. R. Ferrari, J. L. Johnson, & W. G. McCown (Eds.), *Procrastination and task avoidance: Theory, research, and treatment* (pp. 113–136). New York, NY: Plenum.
- Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., & Hewitt, J. (2008). Individual differences in executive function are almost entirely genetic in origin. *Journal of Experimental Psychology: General*, 137, 201–225. doi:10.1037/0096-3445.137.2.201
- Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, 14, 449–468.
- Grope, P., & Steel, P. (2008). A mega-trial investigation of goal setting, interest enhancement, and energy on procrastination. *Personality and Individual Differences*, 45, 406–411. doi:10.1016/j.paid.2008.05.015
- Hannon, R., Adams, P., Harrington, S., Fries-Dias, C., & Gipson, M. T. (1995). Effects of brain injury and age on prospective memory self-rating and performance. *Rehabilitation Psychology*, 40, 289–298.
- Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, 3, 424–453. doi:10.1037/1082-989X.3.4.424
- Jaffe, E. (2013, April). Why wait? The science behind procrastination. *Observer*, 26, 12–16.
- Keller, M. C., Garver-Apgar, C. E., Wright, M. J., Martin, N. G., Corley, R. P., Stallings, M. C., . . . Zietsch, B. P. (2013). The genetic correlation between height and IQ: Shared genes or assortative mating? *PLoS Genetics*, 9(4), Article e1003451. Retrieved from <http://www.plosgenetics.org/article/info%3Adoi%2F10.1371%2Fjournal.pgen.1003451>
- Krause, K., & Freund, A. M. (2013). How to beat procrastination: The role of goal focus. *European Psychologist*. Advance online publication. doi:10.1027/1016-9040/a000153
- Kuhl, J. (1994). Action versus state orientation: Psychometric properties of the Action Control Scale (ACS-90). In J. Kuhl & J. Beckman (Eds.), *Volition and personality: Action versus state orientation* (pp. 47–59). Göttingen, Germany: Hogrefe.
- Kuhl, J., & Fuhrmann, A. (1998). Decomposing self-regulation and self-control: The Volitional Components Inventory. In J. Heckhausen & C. S. Dweck (Eds.), *Motivation and self-regulation across the life span* (pp. 15–49). New York, NY: Cambridge University Press.
- Lay, C. H. (1986). At last, my research article on procrastination. *Journal of Research in Personality*, 20, 474–495.
- Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist*, 57, 705–717.
- Lynam, D. R., Smith, G. T., Whiteside, S. P., & Cyders, M. A. (2006). *The UPPS-P: Assessing five personality pathways to impulsive behavior*. West Lafayette, IN: Purdue University.
- Martin, N. G., Eaves, L. J., Kearsley, M. J., & Davies, P. (1978). The power of the classical twin study. *Heredity*, 28, 79–95.
- Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, 21, 8–14. doi:10.1177/0963721411429458
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41, 49–100. doi:10.1006/cogp.1999.0734
- Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Author.
- Niv, S., Tuvblad, C., Raine, A., Wang, P., & Baker, L. A. (2011). Heritability and longitudinal stability of impulsivity in adolescence. *Behaviour Genetics*, 42, 372–392. doi:10.1007/s10519-011-9518-6
- Pychyl, T. A., & Flett, G. L. (2012). Procrastination and self-regulatory failure: An introduction to the special issue. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, 30, 203–212. doi:10.1007/s10942-012-0149-5
- Rabin, L. A., Fogel, J., & Nutter-Upham, K. E. (2011). Academic procrastination in college students: The role of self-reported executive function. *Journal of Clinical and Experimental Neuropsychology*, 33, 344–357. doi:10.1080/13803395.2010.518597

- Rhea, S. A., Gross, A., Haberstick, B. C., & Corley, R. P. (2013). Colorado Twin Registry: An update. *Twin Research and Human Genetics*, 16, 351–357. doi:10.1017/thg.2012.93
- Senecal, C., Koestner, R., & Vallerand, R. J. (1995). Self-regulation and academic procrastination. *Journal of Social Psychology*, 135, 607–619.
- Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, 133, 65–94. doi:10.1037/0033-2909.133.1.65
- Steel, P. (2010). *The procrastination equation: How to stop putting things off and start getting stuff done*. Toronto, Ontario, Canada: Random House.
- Steel, P., & Ferrari, J. (2013). Sex, education and procrastination: An epidemiological study of procrastination characteristics from a global sample. *European Journal of Personality*, 27, 51–58. doi:10.1002/per.1851
- Steel, P., & König, C. J. (2006). Integrating theories of motivation. *Academy of Management Review*, 31, 889–913. doi:10.5465/AMR.2006.22527462
- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, 72, 271–322. doi:10.1111/j.0022-3506.2004.00263.x
- Tsukayama, E., Duckworth, A. L., & Kim, B. (2012). Resisting everything except temptation: Evidence and an explanation for domain-specific impulsivity. *European Journal of Personality*, 26, 318–334. doi:10.1002/per.841
- Wallace, J. C. (2004). Confirmatory factor analysis of the Cognitive Failures Questionnaire: Evidence for dimensionality and construct validity. *Personality and Individual Differences*, 37, 307–324. doi:10.1016/j.paid.2003.09.005